Space Weather Technical Forecast

Issued on Saturday, 07 January 2023 at 01:12 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of X-class flares throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been High with an impulsive X1.2 flare at 06/0057 UTC, originating from AR3182 (Eki/Beta-Gamma) in the southeast quadrant, which remains the largest region on the visible disc. The X1.2 flare also produced an R2-R3 radio blackout. This region has a complex magnetic structure, which may contain a delta spot, although the region needs to rotate further across the Sun for a clearer analysis. There are four other numbered regions on the visible disc, of which AR3180, AR3181 and AR3183 also have beta-gamma classifications, although are much smaller than AR3182. These regions, along with AR3177, therefore have the potential to produce significant flares. This is despite the current simple classification of AR3177 (Cro/alpha) which has a history of producing large C-class flares. However, AR3180 appears stable. Two small, weak and simple and unnumbered regions have recently emerged in the western hemisphere, although both are approaching the western limb. No Earth-directed CMEs have been observed in the past 24 hours.

Solar Wind / Geomagnetic Activity: Solar winds, observed at L1 occasionally reached elevated levels and peaked at 546 km/s at 06/0903 UTC, but were generally at slightly elevated speeds around 440-490 km/s. Density was average to above average, peaking at 22 ppcc. Total magnetic field strength (IMF) started and ended the day at weak levels, but was predominantly at moderate levels, peaking at 12nT at 06/0841 UTC. The north-south component Bz was predominantly positive, with isolated weakly negative fluctuations, reaching -6 nT at 06/1235 UTC. Phi angle was negative (towards the Sun) throughout. Geomagnetic activity remained at Quiet levels (Kp 0-1). The solar wind environment indicated a connection to a HSS from either CH60 or CH61.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at background levels. High energy electron flux (greater than 2MeV) has been at background to moderate levels, peaking at 142 pfu at 06/0155 UTC. The 24-hour integrated electron fluence remained below the Active threshold with a falling trend, reaching 1.74e6 integrated pfu by 07/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is likely to be Low to Moderate, with a chance of X-class flares through the forecast period, these most likely from AR3182.

Solar Wind / Geomagnetic Activity: The current high speed stream (HSS), from either coronal hole 60 or 61, is likely to persist today and tomorrow (7th and 8th Jan), before possibly declining through day 3 (9th). During day 4 (10th) a new HSS from CH62/- is expected to arrive, with speeds again around 450-500 km/s.

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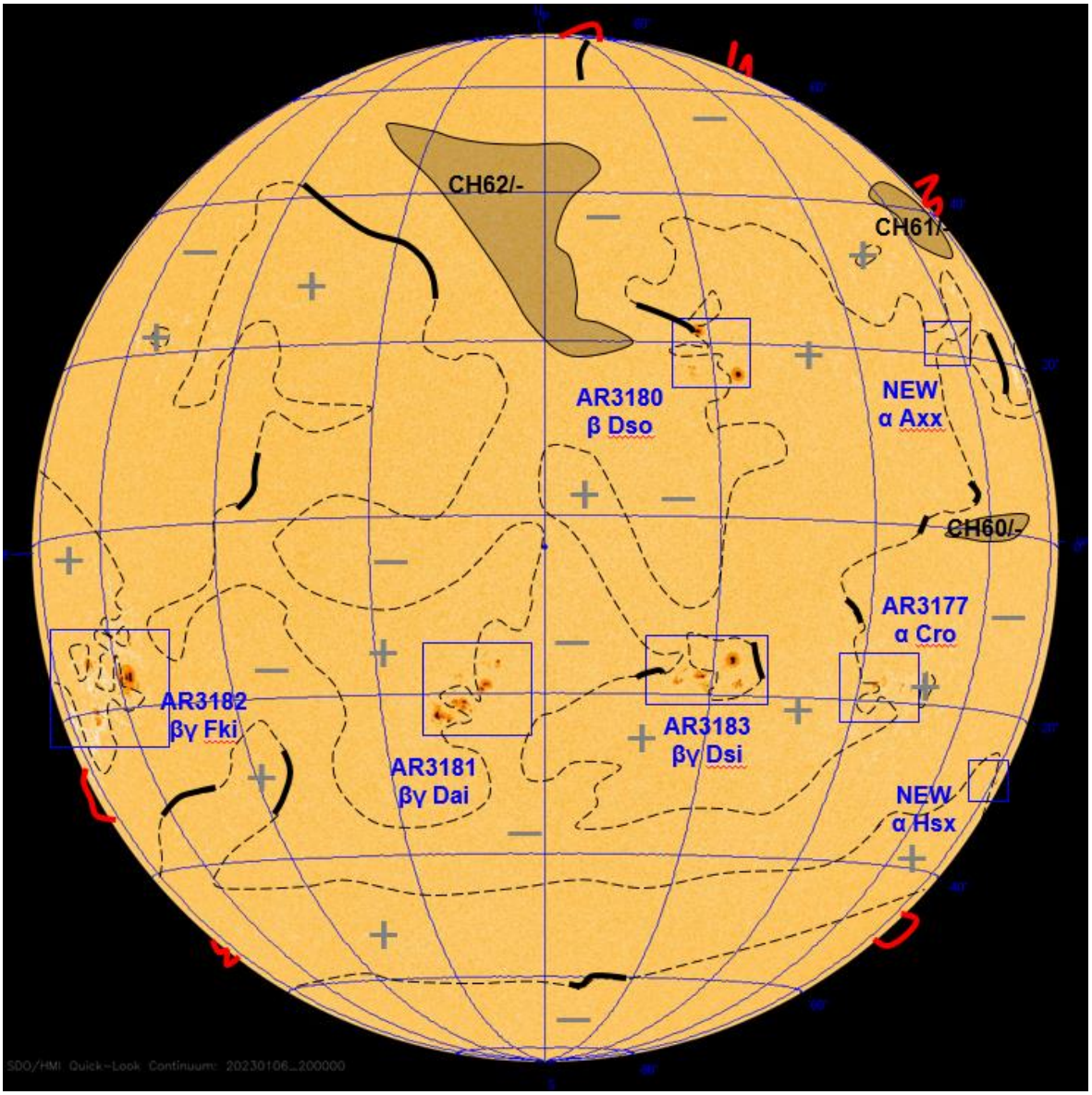
Therefore for much of the period the solar wind is expected to be at slightly elevated to elevated levels, although probably temporarily decreasing to background levels on day 3. Geomagnetic activity is expected to be mostly Quiet (Kp 0-2) but with isolated Unsettled (Kp 3) intervals possible today and tomorrow. Day 4 conditions are likely to increase slightly to become Unsettled, perhaps Active (Kp 4).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES-16 is expected to remain at background levels throughout with a chance of rising alongside any notable flares, giving a slight chance of exceeding the S1/Minor Storm threshold. High energy electron flux (greater than 2MeV) levels are expected to be at background to moderate levels. Therefore the corresponding electron fluence values are forecast to remain below the Active (1e8 integrated pfu) levels, despite an increasing trend.

Figure 1. Solar Analysis Valid 06/2000 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

Current solar wind slightly elevated to elevated conditions indicate the connection to a HSS, from either CH60 or CH61. Looking at Stereo Ahead data where the solar wind speed appears to still be around 500 km/s, which would indicate that the HSS will be slow to decline, persisting around current levels for at least one more day. Persistence would also support a gradual decline in the HSS. The solar wind may decline to reach background levels temporarily through day 3 (9th), before a further HSS from CH62 is likely to arrive through day 4 (10th) with solar winds likely to return to 450-500 km/s.Geomagnetic activity is expected to be mostly Quiet (Kp 0-2) but with isolated Unsettled (Kp 3) intervals possible today and tomorrow. Day 4 conditions are likely to increase slightly to become Unsettled, perhaps Active (Kp 4).
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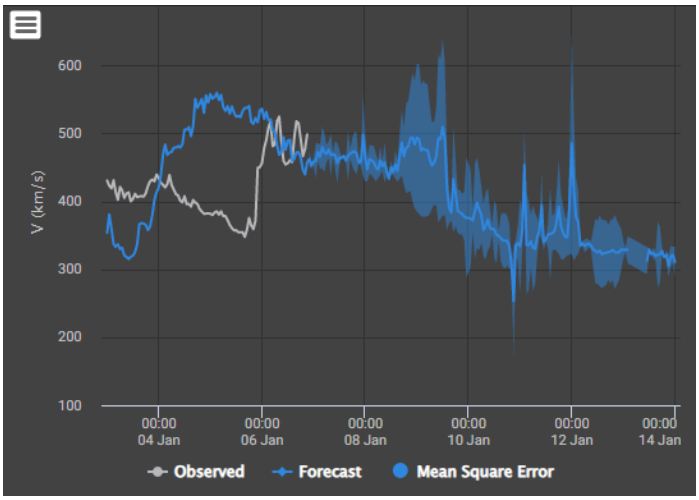
Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	5	5	1	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2: Met Office persistence model.



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Radio Blackouts - X-Ray Flares:

There are currently five numbered sunspot regions on the visible, with two very small and weak un-numbered regions in the western hemisphere, both approaching the limb. AR3182 remains the largest and most magnetically complex in the southeast quadrant. This region remains classified as a Fki/Beta-Gamma. One or more delta spots may be present, but validation of this will come once analysis is easier as the region continues to rotate away from the southeast limb. AR3177 in the western hemisphere remains uni-polar, and continues to show decay. Some minor growth was observed in AR3181 and AR3182, with slightly more significant growth for AR3183 where the trailing spots have consolidated and penumbra has enlarged, leading to the potential for a small delta spot to be present.
Solar activity has been High with an X1.2 flare from AR3182 at 06/0057 UTC. Solar activity is likely to be mainly Low to Moderate with a chance of X-class flares. AR3182 remains the most likely region to produce a significant flare, but most remaining areas have contributed C-class flares over the past 24 hours and therefore cannot be dismissed.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	50	50	50	50
Very Active	R3 to R5 X Class	Yes	20	20	20	20

Figure 3: SDO/AIA 304 showing the X-class flare occurring from AR3182.

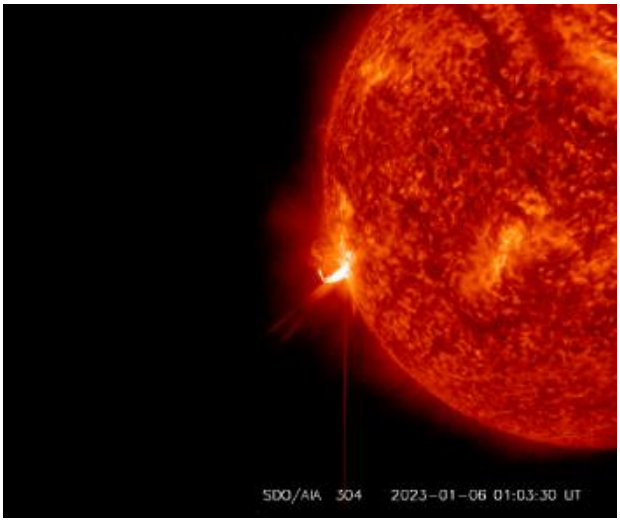

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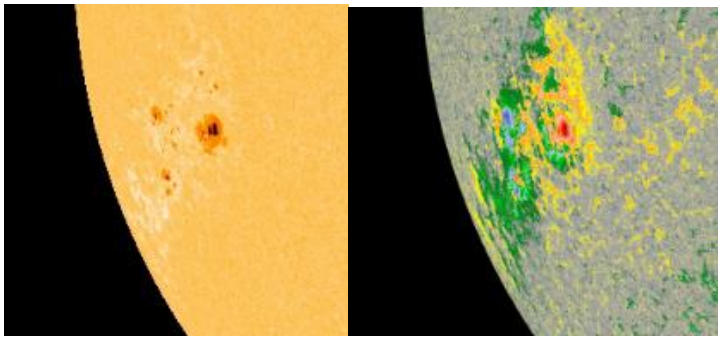
Figure 4: Recent SDO/HMI intensitygram (left) and magnetogram (right) showing AR3182.



Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) measured by GOES-16 is at background levels. Any significant flares will bring a risk of proton flux rising at points during the period, with a slight chance of exceeding the S1/Minor Storm threshold. This risk increases slightly through the period, due mainly to the risk presented by AR3182 as it rotates further across the visible disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	10	10	20	20
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) has been at background to moderate levels. No significant change is expected at first. Later in the forecast period predominantly moderate levels of the high energy electron flux are expected, due to continued coronal hole influence, initially from either CH60 or CH61, then during day 4 from CH62. The corresponding electron fluence values are forecast to remain below the Active (1e8 integrated pfu) levels, despite an increasing trend. The Met Office REFM model is therefore considered to be offering good guidance.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	10	10	20	30
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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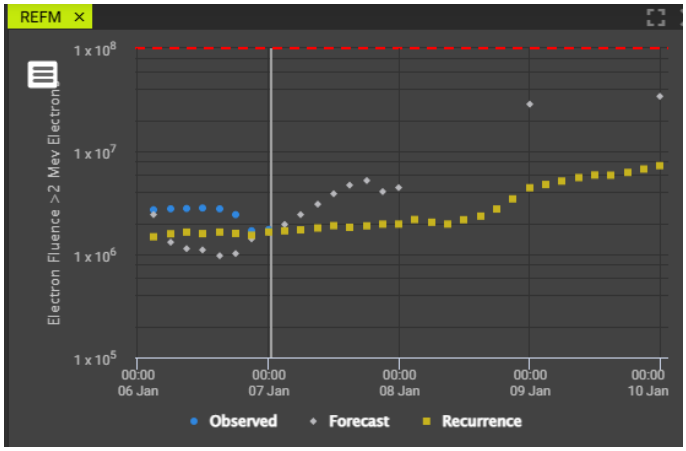
Figure 5: Met Office REFM model.



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